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The Effects of Demographic Variables on Measuring the Cost of Time in Recreation Demand Analysis

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Abstract

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The McConnell/Strand model requires that all individuals value recreational time at constant percent of income. We modify this model to allow time value to vary with demographic characteristics. Value estimates of Ohio Lake Erie private-boat fishing with and without demographics are compared. Consumer's surplus is over-estimated when demographics are excluded.

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The importance of time costs in a travel cost model to recreation benefit estimation has been generally accepted. However, even though theoretical consideration and empirical treatments of time have been studied by a number of authors; for example Bockstael et al.(1987), Smith et al.(1983), McConnell and Strand (1981), Wilman (1980), there is no consensus about which method is the best one.

Recently, the household production framework by Becker (1965) has been applied and become a mainstream in recreational demand analysis (e.g. Bockstael et al., McConnell and Strand, etc.). In this framework, household decision making is concerned with the efficient use of market goods, time, and human capital as inputs in the production of utility yielding non-market goods, such as recreational trips. The household optimizes the choices in two stages. In the first stage, the household minimizes the cost of production subject to the output function and technology. In the second stage the individual maximizes his utility by choosing the number of trips and other commodities subject to a budget constraint and a time constraint. This framework assumes that work time and the time input for recreational trips are substitutes. Therefore, recreational time is valued at the individual's wage rate.

Based on the second stage of the household production framework, McConnell and Strand (M&S hereafter) developed a model that can evaluate time cost at a proportion of the wage rate. Unsatisfied by other studies where '...the choice of the percentage of the wage rate is arbitrary, independent of the sampled population' (p.153), McConnell and Strand argued that the *a priori* evidence on the value of time is inconclusive and therefore proposed a method that allows this proportion to be determined by different samples.

The M&S method gave a new direction in evaluating time cost in recreational models. However, as they also noted, their method requires that '...the ratio of the opportunity cost of time to income per unit of time be constant for all sample observations' and suggests that '... a significant improvement would be to let this ratio change as a function of ... occupation' (p.156).

The purpose of this paper is to develop a modified recreational demand model which permits demand behavior to vary among individuals to include valuation of human time. In particular, we propose that the value of recreational time is affected by the socio-psychological characteristics of the individuals. Economic values of Ohio's Lake Erie water-oriented recreation activities are estimated and compared, based on the estimated recreation demand functions specified by the traditional travel cost model (TCM hereafter), the M&S model, and a modified M&S model.

The McConnell and Strand Model

As in the second stage of the household production framework, the individual is assumed to select the amount of the consumption commodities and the visits to a recreation site to maximize utility subject to budget and time constraints. We assume that only the recreation trips require time input and

(1) $$\max_{Z,X} U(Z, X)$$

$$\text{s.t.} \quad P_Z Z + P_X X = [Y(t_w) + E](1-r)$$

$$\Sigma t_t Z + t_w = T$$

where Z = recreational trips, X = a bundle of all other goods, P_Z = monetaty costs per recreational trip, P_X = price of X, Y = wage income, E = fixed income, r = income tax rate, t_t = total time spent per trip, t_w = work time, and T = total time available. If we assume that recreational time and work are perfect substitutes, the time constraint can be substituted into the income constraint. The first order condition for Z is

(2) $$\partial U/\partial Z = \lambda[P_Z + (1-r)t_t\ (\partial Y/\partial t_w)]$$

If the income tax rate is zero, the recreational trip demand function is:

(3) $$Z = Z\ [\ P_Z+t_tY'(t_w),\ P_X,\ Y+E\ ]$$

If average income is defined by $a = [Y(t_w)+E]/t_w$, nonwork income E is zero, and marginal work income $Y'(t_w)$ is constant, then $Y'(t_w) = Y(t_w)/t_w = a$.

If we suppose that the opportunity cost of time is a fraction of the average income, then the demand function is

(4) $$Z_i = Z_i\ (TC_i,\ P_{xi},\ Y_i)$$

where i = individual i, $TC_i = P_{zi} + kt_{ti}a_i$ is total cost which includes monetary costs P_{zi} and time cost $kt_{ti}a_i$, and k is the percentage of the average income at which the individual values recreational time. This is the M&S model where k is a constant determined by the sample. With a linear demand function, the M&S model is

(5) $$\begin{aligned} Z_i &= b_0 + b_1TC_i + b_2P_{xi} + b_3Y_i \\ &= b_0 + b_1(P_{zi}+kt_{ti}a_i) + b_2P_{xi} + b_3Y_i \\ &= b_0 + b_1P_{zi} + \beta_1t_{ti}a_i + b_2P_{xi} + b_3Y_i \end{aligned}$$

and k can be obtained by

(6) $$k = \beta_1/b_1$$

Modified M & S Model

An extension of the M&S model is to hypothesize that k, the percentage of average income at which <u>each individual</u> values recreational time, is a function of each individual's socio-psychological characteristics. We denote the demographic variables by $D = (d_1, ---, d_n)$ where d_j's are variables such as age, sex, early experiences obtained from recreation, and attitude in recreation activities. Equation (4) can be generalized as

(7) $$Z_i = Z_i\ [\ TC_i(D),\ P_{xi},\ Y_i\ ]$$

where

(8) $$TC_i(D) = P_{zi} + k_i(D)t_{ti}a_i$$

If k_i is a linear function of the demographic factors, then

(9) $$k_i = k_i(D) = \gamma_0 + \Sigma\ \gamma_j d_{ji}$$

describes the percentage of average income at which individual i values recreational time as a function of j demographic variables. With a linear functional form, the modified M&S recreation trip demand can be written as:

(10) $$Z_i = b_0 + b_1 TC_i(D) + b_2 P_{xi} + b_3 Y_i$$

(11) $$= b_0 + b_1\ [P_{zi} + k_i(D)\ t_{ti}\ a_i] + b_2 P_{xi} + b_3 Y_i$$

(12) $$= b_0 + b_1 P_{zi} + b_1(\gamma_0 + \Sigma\gamma_j d_{ji})t_{ti}a_i + b_2 P_{xi} + b_3 Yi$$

(13) $$= b_0 + b_1 P_{zi} + \beta_1 t_{ti}a_i + \Sigma\beta_{2j}d_{ji}t_{ti}a_i + b_2 P_{xi} + b_3 Y_i$$

This gives

(14) $$k_i = (\partial Z/\partial t_t a)/(\partial Z/\partial P_z) = (\beta_1 + \Sigma\ \beta_{2j}d_{ji})/b_1$$

If the demographic variables have no effect on the individual's valuation of recreation time, then β_{2j}'s are zero and the modified demand function reduces to the M&S model.

The Empirical Model and Results

A random sample of 1,481 private-boat sport anglers were selected at ramps and marinas of Ohio's Lake Erie during the summer of 1987 and then mailed questionnaires in February, 1988. A total of 858 completed questionnaires were returned. The questionnaire contained questions requesting information about participation in private-boat sport fishing activities which occurred at Lake Erie and about the costs incurred and the time used to participate in the activities. Data was also collected on socio-psychological variables hypothesized to influence the demand for recreational participation. Eliminating those responses with missing data for relevant variables, we have 728 observations for use in our analysis.

Where the sample is characterized by including recreational participants only, the truncated Tobit model is appropriate. The truncated Tobit model is defined as (Amemiya, p.363):

(15) $$Z_i^* = X_i'\beta + U_i \qquad i = 1, 2, \ldots, n$$

(16) $$= b_0 + b_1 TC_i(D) + b_2 P_{Xi} + b_3 Y_i + U_i$$

$$Z_i = Z_i^* \qquad \text{if } Z_i^* > 0$$

where Z_i, the number of trips made by the sample respondents, equals Z_i^* the number of trips actually made for participants, while neither Z_i nor X_i are observable when $Z_i^* <= 0$. The vector U_i is assumed to be independently and normally distributed, with mean zero and a common variance σ^2.

The likelihood function for the truncated Tobit estimator is

(17) $$L = \pi\Phi(X'_i\beta/\sigma)^{-1}\sigma^{-1}\phi[(Z_i - X'_i\beta)/\sigma]$$

where $\Phi(\ )$ and $\phi(\ )$ are the distribution and density functions of the standard normal variable $X_i'\beta/\sigma$, respectively. By maximizing the conditional likelihood function, the estimates of the parameters of the recreational demand functions can be obtained.

In our empirical analysis, the total cost (TC) includes monetary travel costs and travel time cost which varies with the individual's demographic characteristics. On site monetary and time costs are not included. We also do not consider substitute sites for Lake Erie in our analysis. As shown in equation (8), the variable TC is measured as the total cost to the individual for monetary and time costs of round-trip traveling from home to Lake Erie. Monetary cost P_z is the round-trip vehicle cost calculated as:

(18) $$P_z = DIST * (0.15 + 0.97/MPG)/GPSZ$$

where DIST represents the weighted round trip miles from the individual's home to visited sites at Lake Erie, \$0.15 is the cost per mile of automobile ownership, maintenance, and oil, \$0.97 is the approximate price of gasoline per gallon in the year 1987, MPG is the miles travelled per gallon of gasoline reported by sample respondents, and GPSZ is the group size of the recreational party reported by the respondents.

For simplicity, we choose only three demographic variables which have been identified as factors of participation in outdoor recreation in sociological studies (Searle & Jackson). We define d_1 as age of the respondent, d_2 as education level of the respondent, and d_3 as family size. It is expected that $0 \le k_i \le 1$ for each individual i. If recreation is a normal good, $\partial Z/\partial P_z$ is expected to be negative while $\partial Z/\partial Y$ is expected be positive. Since the coefficient of P_z is negative and k is positive, $\partial Z/\partial t_t a$ is expected to be negative.

First we compare the TCM, the M&S model, and the modified M&S model. As shown in Table 1, both the estimated M&S model and the modified M&S model have coefficients of expected signs and are significant. The log likelihood ratio

Table 1. ML Estimates of TCM, M&S, and Modified M&S Models

Equation	b_0	b_1	β_1	β_{21}	β_{22}	β_{23}	b_5	b_6	b_7	b_8	σ	LRT_0#	LRT_1#	LRT_2#
TCM	-1.39	-1.90					-.0002				12.2	58	-	-
		(14)*					(2.0)							
M&S	-1.12	-.52	-.289								13.4	84	26	-
		(2.3)	(6.2)											
Modified M&S	5.45	-.82	-.34	.009	-.012	-.03		.21	-.72	.37	14.1	122	64	38
		(3.7	(1.6)	(3.3)	(1.3	(1.5)		(1.9)	(.8)	(.3)				

* t-statistics

\# $LRT_i = -2(\log L_i - \log L_j)$, i=0 for the null equation, i=1 for the TCM equation, and i=2 for the M&S equation; $X^2_{0.05,2}=5.99$, $X^2_{0.05,6}=12.59$

Table 2. Percentage of Average Income at Which the Individual Values Recreational Time and Total Cost Estimates

Equation	k_i	Mean k_i* (%)	Mean TC* ($/angler/trip)
TCM	-	-	9.59
M&S	-	55.19	41.78
Modified M&S	$.418-.0108d_1+.015d_2+.0365d_3$	16.16	19.02

* mean k_i and TC are calculated at the means of d's for the modified M&S model
d_1 = age of the respondent, d_2 = education level of the respondent, and
d_3 = family size of the respondent.

of the modified M&S model as compared to null equation without any variables (LRT_0), the TCM model (LRT_1), and the M&S model (LRT_2) are highly significant (Table 1). This test implies the demographic variables have significant effect on the valuation of travel time cost.

In Table 2 we present the values of k_i and the corresponding total cost. The calculated estimate of mean k_i for the modified M&S model, as calculated in equation (14), is 0.1616 and is about 40% lower than that for the M&S model, as calculated in equation (6). While in the M&S model the k for the sample is 55.19%, the estimated modified M&S model gives:

(19) $k_i = 0.418 - 0.0108d_{1i} + 0.015d_{2i} + 0.0365d_{3i}$

For example, an individual at the age of 30 (d_1), who completed 10 years of education (d_2), with 2 persons in the household (d_3), values time for recreational trips at 31.7% of his wage rate. Both education and household size have positive effects on the valuation of time while age has a negative effect on it.

Welfare Estimates

Based on the estimated recreation demand functions and mean values of total cost and trips, the average willingness to pay and the average consumer's surplus for the sample are presented in Table 3. Each economic value is calculated at the sample mean trip at 21.7 for the anglers. The estimated willingness to pay for the modified M&S recreation demand is $684.13 per angler per year, while the estimated WTP for the M&S model, which does not incorporate demographic factors in measuring the cost of time, is $1331.93 per angler per year. Meanwhile, the WTP for the TCM is $325.13 per angler per year. Consumer's surplus is $439.13 per angler per year for the M&S recreation demand function and $120.20 for the TCM, while the modified M & S model implied consumer's surplus of $277.69. This implies that when time cost is not included in the total cost (TCM) the consumer's surplus is under-estimated, while when time cost is included at a constant percentage of wage rate (M&S) the consumer surplus is over-estimated.

Table 3. Average Economic Values.

Equation	Consumer's Surplus ($/angler/year)	Willingness to Pay ($/angler/year)
TCM	120.20	325.13
M&S	439.13	1,331.93
Modified M&S	277.69	681.13

According to Ohio's Fishery Report on private-boat angler hours and the means of total fishing hour per angler per year in our sample, about 33,342 anglers made trips to Lake Erie in 1987. The aggregate economic values is shown in Table 4. The aggregate consumer's surplus of the modified M&S is about 35% lower then that of the M&S model, and is about 57% higher than that of the TCM.

Table 4. Aggregate Economic Values
($/year)

Equation	Consumer's Surplus	Willingness to Pay
TCM	4,007,708	10,840,484
M&S	14,641,472	44,409,210
Modified M&S	9,258.740	22,710,236

Conclusion

We have modified the McConnell and Strand model to allow the value of time cost to vary with the individual's demographic characteristics. The truncated Tobit model was specified for estimation since the data set includes only participants of private-boat fishing. Conditional maximum likelihood method was applied in estimation. The demographic factors of family size, age, and education level significantly affect the individual's valuation of time cost on private-boat fishing activities.

Incorporation of socio-psychological factors into the estimation of time cost (modified M&S) results in higher estimated responses to travel costs and lower valuation of time than when socio-psychological factors are excluded (M&S). The consumer's surplus, which was calculated at the sample means of variables using the estimated recreational demand, shows that the economic value of Lake Erie for private-boat fishing is about $277.69 per angler per year. This is about 35% lower than in the original M&S model where demographic variables are not allowed to affect time value. With estimated Ohio Lake Erie private-boat anglers of 33,342 in 1987, the aggregate consumer's surplus is approximately $928,092, which is about 35% lower than when demographic variables are excluded from affecting time cost valuation.

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